General

Guideline Title

ACR Appropriateness Criteria® clinically suspected pulmonary arteriovenous malformation (PAVM).

Bibliographic Source(s)

Hanley M, Ahmed O, Chandra A, Gage KL, Gerhard-Herman MD, Ginsburg M, Gornik HL, Johnson PT, Oliva IB, Ptak T, Steigner ML, Strax R, Rybicki FJ, Dill KE, Expert Panel on Vascular Imaging. ACR Appropriateness CriteriaÂ® clinically suspected pulmonary arteriovenous malformation (PAVM). Reston (VA): American College of Radiology (ACR); 2015. 6 p. [21 references]

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Clinically Suspected Pulmonary Arteriovenous Malformation (PAVM)

Radiologic Procedure	Rating	Comments	RRL*
US echocardiography transthoracic bubble study	8		O
CTA chest with contrast	8	This procedure is often used following positive TTE.	
X-ray chest	7	This procedure is complementary to other examinations, such as TTE.	
US echocardiography transesophageal bubble study	6	This procedure is the reference standard for detecting right-to-left shunts but is more invasive than TTE.	O
MRA chest without and with contrast	6		O

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate | *Relative

Radiologic Procedure	Rating	Comments	RRL*
CT chest without contrast	6		
Arteriography pulmonary	5	Although this procedure is appropriate for preinterventional planning, it is usually not appropriate as an initial test.	
US transcranial bubble study	5	This procedure is an alternative to TTE, although it is less widely available.	O
Tc-99m pertechnetate-labeled albumin pulmonary scan	4		
MRA chest without contrast	3		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Introduction/Background

Pulmonary arteriovenous malformations (PAVMs) are vascular structures that most commonly result from abnormal communication between pulmonary arteries and pulmonary veins. The majority of PAVMs are congenital in nature due to a developmental defect in the capillary bed resulting in a right-to-left intrapulmonary shunt. PAVMs are more often solitary and simple, although multiple and/or complex forms are described. Although PAVMs <2 cm are usually asymptomatic, larger AVMs can cause clinical symptoms. Although uncommon, PAVMs are often considered in the differential diagnosis of common disease states including hypoxemia, hemoptysis, brain abscesses, and paradoxical stroke, as well as in the differential for pulmonary nodules.

Approximately 90% of PAVMs occur in patients with hemorrhagic hereditary telangiectasia (HHT), also known as Osler-Weber-Rendu syndrome. HHT is an autosomal dominant disease with variable expression and an estimated prevalence of 1 in 5000. HHT commonly presents with epistaxis or visible mucocutaneous telangiectasia and is often complicated by PAVMs as well as vascular malformations of the brain, gastrointestinal tract, and liver. The incidence of PAVMs in patients with HHT is 30% to 50%. HHT is classically a clinical diagnosis, and although genetic testing is available, it remains complex due to multiple mutations that are family specific.

In addition to the congenital PAVMs common to HHT, PAVMs can also be acquired through trauma or infection, associated with hepatopulmonary syndrome in the setting of chronic liver disease, or after surgical repair of congenital heart disease (bidirectional cavopulmonary shunt).

PAVMs do not have malignant potential, but they can enlarge with time and require follow-up. The treatment of PAVMs has traditionally been recommended when the feeding vessel is >3 mm, regardless of the clinical presentation, due primarily to potential neurological complications. However, more recent reports of PAVMs with feeding vessels <3 mm causing symptomatic paradoxical emboli has resulted in many centers treating PAVMs smaller than the previously established cutoff. Technical factors can limit the treatment of PAVMs with feeding vessels <1.5 mm. After successful embolization of PAVMs, echocardiography often remains positive, so patients often begin lifelong follow-up in 3- to 5-year intervals with computed tomography (CT) or magnetic resonance angiography (MRA).

Echocardiography

Although transesophageal echocardiography bubble studies are considered the reference standard to screen for right-to-left shunt, transthoracic echocardiography (TTE) bubble studies are more commonly used given noninvasiveness and low cost.

A TTE bubble study uses agitated saline as a contrast agent and is considered positive for a right-to-left shunt when microbubbles are visualized in the left atrium after 3 to 8 cardiac cycles. A grading system (0–3) has been developed that correlates with the presence of PAVMs on CT and also with neurological complications. However, this modality does not provide anatomical information such as size and location of PAVMs.

A group of researchers reviewed the diagnostic accuracy of screening for PAVMs with chest radiographs, arterial-arterial partial pressure of oxygen (PO_2) gradient ($AaPO_2$), TTE bubble studies, and radionuclide pulmonary scintigraphy in 105 patients with HHT. This retrospective review used CT and/or pulmonary angiography (PA) as the reference standard. TTE bubble study was the most sensitive (93%) for the diagnosis of PAVMs, followed by radionuclide scintigraphy (71%), chest radiograph (70%), and $AaPO_2$ gradient (62%). Combining TTE bubble studies and chest radiographs led to 100% sensitivity and specificity.

Another group of authors prospectively evaluated patients for PAVMs who were referred for HHT screening. Patients (n=299) underwent a TTE bubble study, noncontrast high resolution CT (HRCT), arterial blood gas analysis, and chest radiography. HRCT was used as the reference standard. Sensitivity of the TTE bubble study was 97%, specificity was 77%, and the negative predictive value was 99%.

The International Guidelines for the Diagnosis and Management of HHT recommends initial screening with a TTE bubble study, followed by thin-section (1–2 mm) CT for positive cases. TTE bubble studies can remain positive in 80% of patients after successful treatment of PAVM.

Transcranial Ultrasound

A research group evaluated ultrasound (US) transcranial bubble studies in 12 patients with HHT in comparison with TTE bubble studies using CT or CT angiography (CTA) as the reference standard. Positive studies demonstrated microbubbles in the middle cerebral artery with a combination of M-mode and spectroscopy after 3 to 7 cardiac cycles after the injection of agitated saline. Both transcranial US and TTE had high sensitivity (100%) and low specificity (38% and 25%, respectively). Although transcranial US could be used as an alternative to TTE, it is less widely available.

Chest Radiograph

Chest radiographs are well established as an initial imaging modality for patients presenting with hypoxemia or hemoptysis, as well as having the ability to suggest alternative diagnoses in patients suspected of having PAVMs. However, chest radiographs alone suffer from low sensitivity to adequately screen patients with suspected PAVMs and may not detect clinically treatable PAVMs. One group of authors reported a sensitivity of 70% and specificity of 98% in 105 patients with HHT. The use of chest radiographs in conjunction with TTE bubble studies can provide 100% sensitivity and specificity in the same study group. Another study reported a sensitivity of 28% and specificity of 100% in 296 patients presenting for HHT screening.

Computed Tomography and Computed Tomography Angiography

Unlike imaging modalities designed to detect right-to-left shunts, CT provides detailed anatomical information for pretreatment planning. A group of researchers demonstrated the utility of thin-section noncontrast CT with 3-D reconstructions in detecting PAVMs prior to PA with a 95% detection rate. The International Guidelines for the Diagnosis and Management of HHT recommends thin-section (1–2 mm) noncontrast CT to follow a positive screening TTE bubble study. After treatment of PAVMs, another group recommended patients begin lifelong follow-up with CTA starting at 6 months and continuing at 3- to 5-year intervals. The added benefit of performing a contrast CT PA must be weighed against the risk of introducing air and paradoxical embolus.

Another study compared CTA and PA in the detection of PAVM in 18 patients with HHT. More PAVMs were detected with CTA than with PA. During the analysis of 42 PAVMs, CTA was reported to have a higher mean sensitivity (83%) compared to PA (68%) but with slightly lower specificity (93% versus 100%, respectively). The use of planar reconstruction, 3-D, and maximum-intensity projections can assist detection.

Magnetic Resonance Angiography

Like CT, contrast-enhanced MRA (CE-MRA) provides anatomical information for pretreatment planning. The avoidance of ionizing radiation is particularly important in the HHT population, who are screened often and potentially starting at a young age.

One group of authors evaluated CE-MRA for the detection of PAVMs in 203 patients with HHT. Detected PAVMs ≥5 mm subsequently underwent PA for possible embolization. CE-MRA detected more PAVMs than PA (119 versus 92), but not all patients underwent PA. Another research group demonstrated the value of time-resolved MRA to assess patency of known PAVMs in patients with HHT. There are inherent limitations of MRA in detecting PAVMs <5 mm, which may have clinical consequences because many centers are treating PAVMs below the established threshold of a 3-mm feeding vessel. Another study reported on the use of time-resolved MRA in follow-up of treated PAVMs. This study demonstrated 49% reperfusion rate at 24 months for primary embolization and 100% for repeat embolization, confirming the need for continued surveillance.

Pulmonary Scintigraphy

Right-to-left shunts can be detected by intravenous injection of technetium (Tc)-99m pertechnetate-labeled albumin. The injected particles measure ≥20 µm and are normally trapped in the capillary bed of the lung. Abnormal activity in the kidney or brain can be seen in the presence of PAVMs, and calculation of a shunt fraction can be performed. A group of researchers reported pulmonary scintigraphy has a sensitivity of 71% in the screening of patients with HHT for PAVMs, only slightly better than chest radiographs. Another group of authors demonstrated agreement between pulmonary scintigraphy and shunt fractions calculated during 100% oxygen arterial blood gas analysis. Another study reported sensitivity and specificity of 87% and 61% for pulmonary scintigraphy in detection of PAVM in patients with HHT. Pulmonary scintigraphy does not provide anatomical information for pretreatment planning or determine who may be eligible for treatment. Similar to TTE bubble studies, pulmonary scintigraphy can remain positive after treatment of PAVMs due to occult lesions or PAVMs that are too small to treat.

Pulmonary Angiography

PA has traditionally been the reference standard for detection of PAVMs, as described in two studies. One of the studies demonstrated significantly fewer PAVMs detected on PA when compared with CE-MRA. The other study demonstrated PA had improved specificity (100% versus 78%) at the cost of sensitivity (70% versus 83%) when compared to CT. Diagnostic PA does remain a critical component of the treatment of PAVMs when performed with concurrent transcatheter embolization.

Summary of Recommendations

- A chest radiograph is usually appropriate in that it is complementary to TTE and may suggest an alternative diagnosis.
- The International Guidelines for the Diagnosis and Management of HHT recommends initial screening with a TTE bubble study, followed by thin-section (1–2 mm) CT for positive cases. The added benefit of performing a contrast CT PA must be weighed against the risk of introducing air and paradoxical embolus.
- Noninvasive imaging examinations including TTE bubble studies and radionuclide perfusion are designed to detect the presence of right-to-left shunts. These, however, do not provide anatomic information such as PAVM location and size, which are critical for treatment decision and planning. They also may remain positive after successful coil embolization.
- Although MRA lacks the special resolution of CT, it has an important role given the lack of ionizing radiation and need for repeat lifelong examinations in patients with HHT potentially starting at a young age.
- Diagnostic PA remains the reference standard for inconclusive cases and remains a critical component of the treatment of PAVMs when performed with concurrent transcatheter embolization.

Abbreviations

- CT, computed tomography
- CTA, computed tomography angiography
- MRA, magnetic resonance angiography
- Tc-99m, technetium-99
- TTE, transthoracic echocardiography
- US, ultrasound

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☐	<0.1 mSv	<0.03 mSv
☐☐	0.1-1 mSv	0.03-0.3 mSv
☐☐☐	1-10 mSv	0.3-3 mSv
☐☐☐☐	10-30 mSv	3-10 mSv
☐☐☐☐☐	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

Pulmonary arteriovenous malformation (PAVM)

Guideline Category

Diagnosis

Evaluation

Screening

Clinical Specialty

Cardiology

Family Practice

Hematology

Internal Medicine

Nuclear Medicine

Pulmonary Medicine

Radiology

Intended Users

Advanced Practice Nurses

Health Plans

Hospitals

Managed Care Organizations

Physician Assistants

Physicians

Students

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of radiologic procedures for patients with suspected pulmonary arteriovenous malformation (PAVM)

Target Population

Patients with suspected pulmonary arteriovenous malformation (PAVM)

Interventions and Practices Considered

1. Ultrasound (US) echocardiography
    - Transthoracic bubble study
    - Transesophageal bubble study
2. Transcranial bubble study
3. Computed tomography angiography (CTA), chest, with contrast
4. X-ray, chest
5. Magnetic resonance angiography (MRA), chest
    - Without and with contrast
    - Without contrast
6. Computed tomography (CT), chest, without contrast
7. Arteriography, pulmonary
8. Technetium (Tc)-99m pertechnetate-labeled albumin pulmonary scan

Major Outcomes Considered

Sensitivity, specificity, and diagnostic accuracy of radiologic procedures in patients suspected of having pulmonary arteriovenous malformations (PAVMs)

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

<u>Literature Search Summary</u>

A literature search was conducted in March 2014 and updated in July 2015 to identify evidence for the *ACR Appropriateness Criteria® Clinically Suspected Pulmonary Arteriovenous Malformation* topic. Using the search strategies described in the literature search companion (see the "Availability of Companion Documents" field), a total of 437 articles were found. Ten articles were used in the topic. Four hundred twenty-seven articles were not used due to either poor study design, the articles were not relevant or generalizable to the topic, or the results were unclear, misinterpreted, or biased.

The author added 10 citations from bibliographies, Web sites, or books that were not found in the literature search.

One citation is a supporting document that was added by staff.

Number of Source Documents

A literature search conducted in March 2014 and updated in July 2015 identified 10 articles that were included in the bibliography. The author added 10 citations from bibliographies, Web sites, or books that were not found in the literature search. One citation is a supporting document that was added by staff.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Definitions of Study Quality Categories

Category 1 - The study is well-designed and accounts for common biases.

Category 2 - The study is moderately well-designed and accounts for most common biases.

Category 3 - The study has important study design limitations.

Category 4 - The study or source is not useful as primary evidence. The article may not be a clinical study, the study design is invalid, or conclusions are based on expert consensus.

The study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);

Or

The study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;

Or

The study is an expert opinion or consensus document.

Category M - Meta-analysis studies are not rated for study quality using the study element method because the method is designed to evaluate individual studies only. An "M" for the study quality will indicate that the study quality has not been evaluated for the meta-analysis study.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The topic author assesses the literature then drafts or revises the narrative summarizing the evidence found in the literature. American College of Radiology (ACR) staff drafts an evidence table based on the analysis of the selected literature. These tables rate the study quality for each article included in the narrative.

The expert panel reviews the narrative, evidence table and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the variant table(s). Each individual panel member assigns a rating based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Rating Appropriateness

The American College of Radiology (ACR) Appropriateness Criteria (AC) methodology is based on the RAND/UCLA Appropriateness Method. The appropriateness ratings for each of the procedures or treatments included in the AC topics are determined using a modified Delphi method. An initial survey is conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. The expert panel members review the evidence presented and assess the risks or harms of doing the procedure balanced with the benefits of performing the procedure. The direct or indirect costs of a procedure are not considered as a risk or harm when determining appropriateness (additional assumptions regarding rating appropriateness can be found in the document Rating Round Information). When the evidence for a specific topic and variant is uncertain or incomplete, expert opinion may supplement the available evidence or may be the sole source for assessing the appropriateness.

The appropriateness is represented on an ordinal scale that uses integers from 1 to 9 grouped into three categories: 1, 2, or 3 are in the category "usually not appropriate" where the harms of doing the procedure outweigh the benefits; and 7, 8, or 9 are in the category "usually appropriate" where the benefits of doing a procedure outweigh the harms or risks. The middle category, designated "may be appropriate," is represented by 4, 5, or 6 on the scale. The middle category is when the risks and benefits are equivocal or unclear, the dispersion of the individual ratings from the group median rating is too large (i.e., disagreement), the evidence is contradictory or unclear, or there are special circumstances or subpopulations which could influence the risks or benefits that are embedded in the variant.

The ratings assigned by each panel member are presented in a table displaying the frequency distribution of the ratings without identifying which members provided any particular rating. To determine the panel's recommendation, the rating category that contains the median group rating without disagreement is selected. This may be determined after either the first or second rating round. If there is disagreement after the first rating round, a conference call is scheduled to discuss the evidence and, if needed, clarify the variant or procedure description. If there is still disagreement after the second rating round, the recommendation is "may be appropriate."

This modified Delphi method enables each panelist to articulate his or her individual interpretations of the evidence or expert opinion without excessive influence from fellow panelists in a simple, standardized, and economical process. For additional information on the ratings process see the Rating Round Information document.

Additional methodology documents, including a more detailed explanation of the complete topic development process and all ACR AC topics can be found on the ACR Web site (see also the "Availability of Companion Documents" field).

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria (AC).

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current medical evidence literature and the application of the RAND/UCLA appropriateness method and expert panel consensus.

Summary of Evidence

Of the 21 references cited in the *ACR Appropriateness Criteria® Clinically Suspected Pulmonary Arteriovenous Malformation* document, all of them are categorized as diagnostic references including 1 well designed study, 2 good quality studies, and 7 quality studies that may have design limitations. There are 10 references that may not be useful as primary evidence. There is 1 reference that is a meta-analysis study.

While there are references that report on studies with design limitations, 3 well designed or good quality studies provide good evidence.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Selection of appropriate radiologic imaging procedures for evaluation of patients with suspected pulmonary arteriovenous malformation (PAVM)

Potential Harms

- The added benefit of performing a contrast computed tomography (CT) pulmonary angiogram (PA) must be weighed against the risk of introducing air and paradoxical embolus.
- The avoidance of ionizing radiation is particularly important in the hemorrhagic hereditary telangiectasia (HHT) population, who are screened often and potentially starting at a young age.

Relative Radiation Level

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the American College of Radiology (ACR) Appropriateness Criteria® Radiation Dose Assessment Introduction document (see the "Availability of Companion Documents" field).

Qualifying Statements

Qualifying Statements

- The American College of Radiology (ACR) Committee on Appropriateness Criteria (AC) and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment

and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.
- ACR seeks and encourages collaboration with other organizations on the development of the ACR AC through society representation on expert panels. Participation by representatives from collaborating societies on the expert panel does not necessarily imply individual or society endorsement of the final document.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

Living with Illness

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Hanley M, Ahmed O, Chandra A, Gage KL, Gerhard-Herman MD, Ginsburg M, Gornik HL, Johnson PT, Oliva IB, Ptak T, Steigner ML, Strax R, Rybicki FJ, Dill KE, Expert Panel on Vascular Imaging. ACR Appropriateness CriteriaÂ® clinically suspected pulmonary arteriovenous malformation (PAVM). Reston (VA): American College of Radiology (ACR); 2015. 6 p. [21 references]

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2015

Guideline Developer(s)

American College of Radiology - Medical Specialty Society

Source(s) of Funding

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Vascular Imaging

Composition of Group That Authored the Guideline

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Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the American College of Radiology (ACR) Web site.

Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2015 Oct. 3 p. Available from the American College of Radiology (ACR) Web site.
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 2015 Feb. 1 p. Available from the ACR Web site.
- ACR Appropriateness Criteria®. Evidence table development. Reston (VA): American College of Radiology; 2015 Nov. 5 p. Available from the ACR Web site.
- ACR Appropriateness Criteria®. Topic development process. Reston (VA): American College of Radiology; 2015 Nov. 2 p. Available from the ACR Web site.
- ACR Appropriateness Criteria®. Rating round information. Reston (VA): American College of Radiology; 2015 Apr. 5 p. Available from the ACR Web site.
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2015 Sep. 3 p. Available from the ACR Web site.
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 2015 Feb; 2 p. Available from the ACR Web site.
- ACR Appropriateness Criteria®. Manual on contrast media. Reston (VA): American College of Radiology; 2015. 129 p. Available from the ACR Web site.
- ACR Appropriateness Criteria® clinically suspected pulmonary arteriovenous malformation (PAVM). Evidence table. Reston (VA): American College of Radiology; 2015. 8 p. Available from the ACR Web site.

- ACR Appropriateness Criteria® clinically suspected pulmonary arteriovenous malformation (PAVM). Literature search. Reston (VA): American College of Radiology; 2015. 1 p. Available from the ACR Web site .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on January 29, 2016.

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